Module 10: Evaluating the Consequences of Alternative strategies and actions—*Bringing scenario planning outputs into decision analysis*

BY
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USFWS

The end of the cold war started global warming.

Stephen Wright

From the guidebook:

Step 13. Evaluate the potential impacts and implications of the scenarios

The goal of this step is to evaluate the ways in which the different scenarios constructed in Phase II might directly and indirectly effect the natural resources of concern (Mahmoud et al. 2009).

Key points:

- Estimate consequences of management alternatives across scenarios in terms of your objectives.
- Develop clear evaluation tools including visualization tools/techniques
- Use conceptual models to link back to your objectives (Probably needs to be used in an earlier module)
- Scenarios may need to be reassessed based on emerging science or the results of monitoring outputs (See Module 7&8)
- Triggers may be necessary to implement specific options

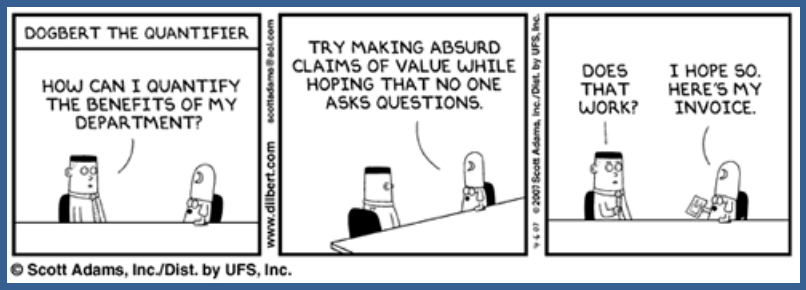
Alternative futures

- The effects of several plausible futures on resources, rather than one most likely future, are examined.
- The appropriateness of new and existing action or strategy options is tested against multiple future conditions.
- Future decisions and their triggers are explicitly articulated while choosing actions to implement in the near-term.
- This effort to identify contingencies and triggers is explicitly linked with monitoring

MIT/GeoAdaptive/GeoDesign/ USGS/USFWS Case study for South Florida

Federal FY 2007

- Just allowed to say climate change
- A billion CC studies
- Workshop/month in Florida
- SFESO set up a climate change team
- Project leader wanted to develop a tool related to climate change for the south Florida refuge system
- Hired Vargas/Flaxman
- Stakeholder group: Ecoteam
- Group initial problem: What do I monitor on my refuge for CC?



FY 2008-2009

- Learning the system
- Problem refinement
- Scenario development
- Refuge write-ups

Seeing Impacts Already…

Courtesy: Paul Krashefski, Broward County

…But a picture is worth...

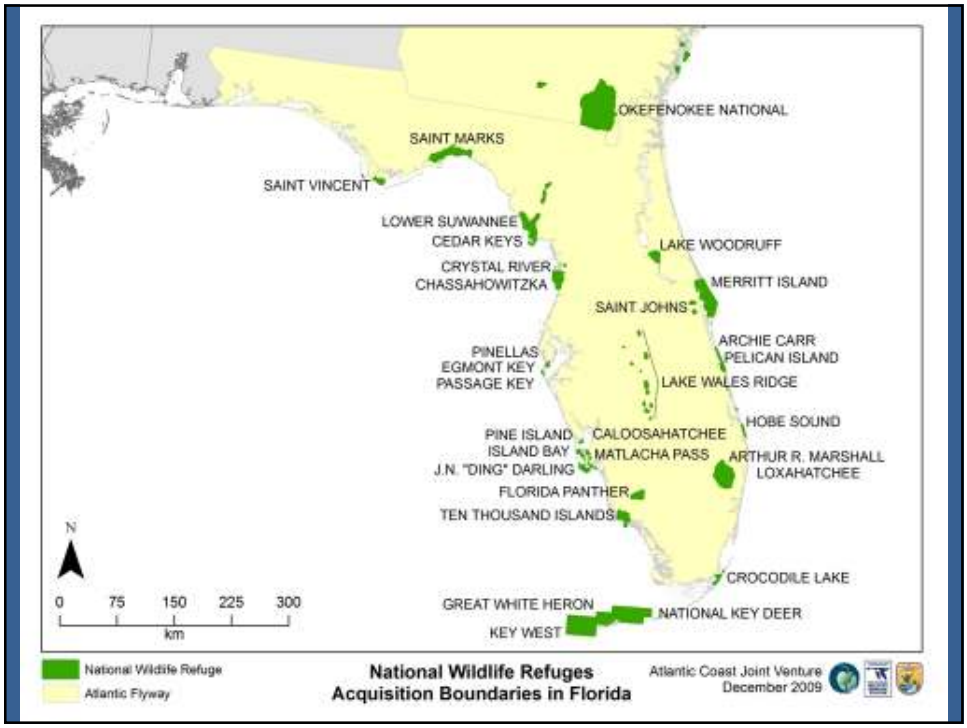
Photo by **Paul Krashefski**

…a thousand words.

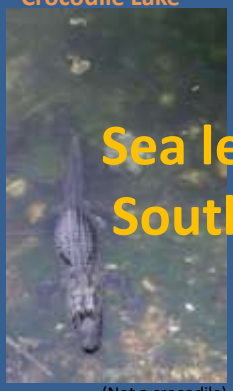
Photo by **Paul Krashefski**

Photo by **Paul Krashefski**

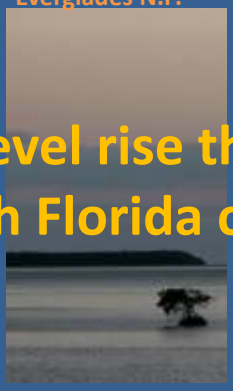
Photo by **Paul Krashefski**

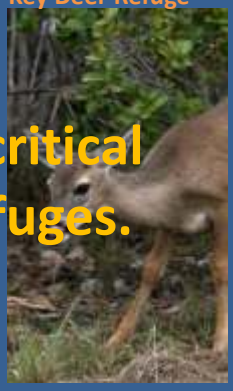


Crocodile Lake | Everglades N.P. | Ding Darling | Key Deer Refuge



(Not a crocodile)



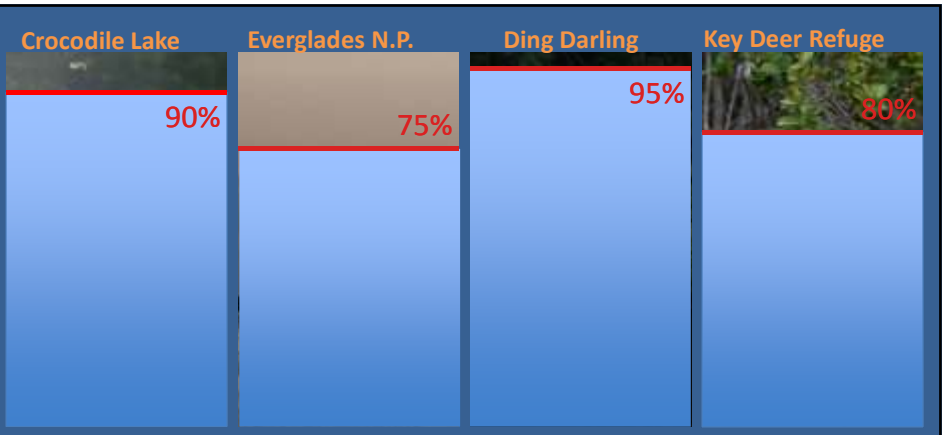


Sea level rise threatens critical South Florida coastal refuges.

How will 1 meter SLR affect key refuges?

How much land will be lost with varying degrees of SLR?

What other damage can we expect?

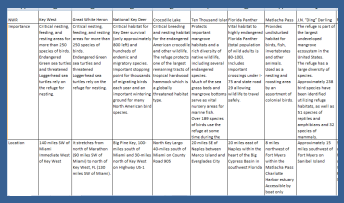


	Sea Level Rise			
Federal Reserve	**3.6”**	**18.4”**	**39.1”**	**113”**
Caloosahatchee National Wildlife Refuge	40%	73%	**100%**	100%
Island Bay National Wildlife Refuge	2.5%	**88%**	93%	100%
Pine Island National Wildlife Refuge	5.5%	**77%**	82%	87%
Ten Thousand Islands NWR	8.1%	**77%**	96%	100%
Hobe Sound National Wildlife Refuge	6.5%	46%	**70%**	83%

Contextual Refuge Analysis

Current and Historic Thematic Mapping

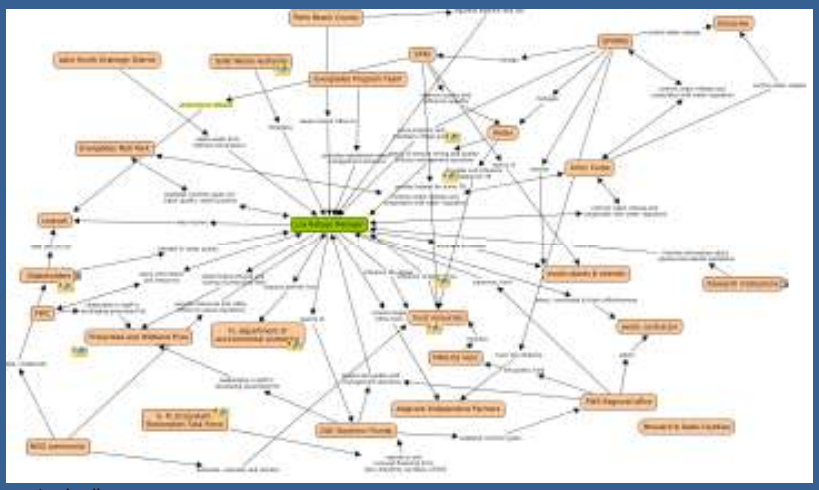
Inventories



Institutional & Decision Making Diagramming

Review of Comprehensive Management Plans

Stakeholder Identification



Major water bodies

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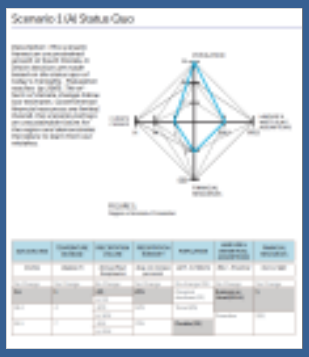
MIT Scenario Dimensions

SEA LEVEL RISE (inches)	TEMPERATURE INCREASE (degrees F)	PRECIPITATION VOLUME (Annual Mean Precipitation)	PRECIPITATION INTENSITY (Avg ann increase per storm)	POPULATION (all FL in millions)	LAND USE & WATER PLNG. ASSUMPTIONS (BAU - Proactive)	FINANCIAL RESOURCES (low vs. high)
No Change	No Change	No Change	No Change	No change (18)	No Change	No Change
36	1	-5%	85%	Marginal decrease (32)	Business as Usual (B.A.U.)	$
48	4	-10%	90%	Trend (35)		
60	7	-15%	95%	Double (39)	Proactive	$$$

SCENARIO	BIOPHYSICAL	POPULATION	WATER & LAND USE PLNG. ASSUMPTIONS	FINANCIAL RESOURCES
A	LOW	DOUBLE	B.A.U.	$
B	LOW	TREND	PROACTIVE	$$$
C	HIGH	TREND	B.A.U.	$
D	HIGH	TREND	PROACTIVE	$$$
E	MID	DOUBLE	B.A.U.	$$$
F	MID	TREND	B.A.U.	$
G	HIGH (3.15' SLR)	LESS	PROACTIVE	$$$
I	HIGH	DOUBLE	PROACTIVE	$
J	LOW	DOUBLE	PROACTIVE	$



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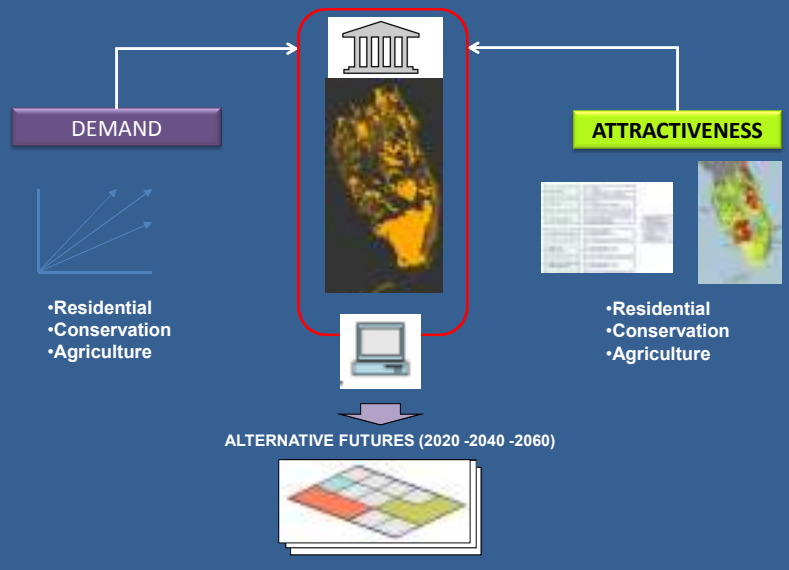
Modeling Process



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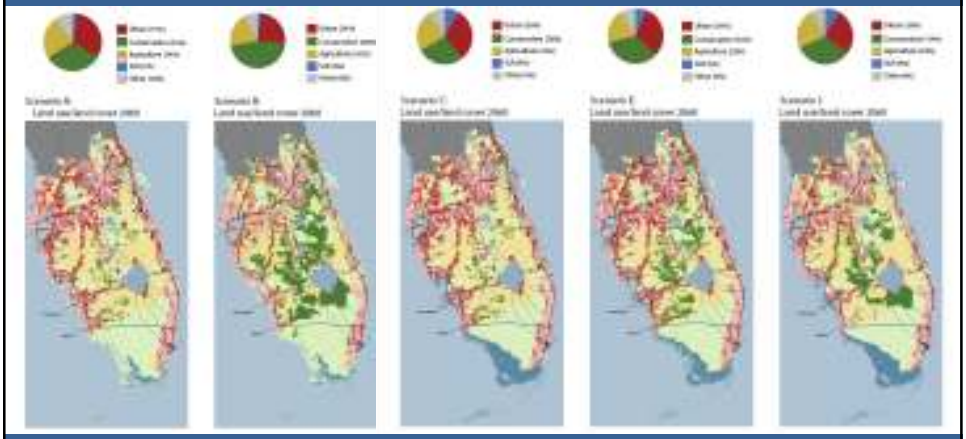
SCENARIO A SCENARIO B SCENARIO C SCENARIO E SCENARIO I



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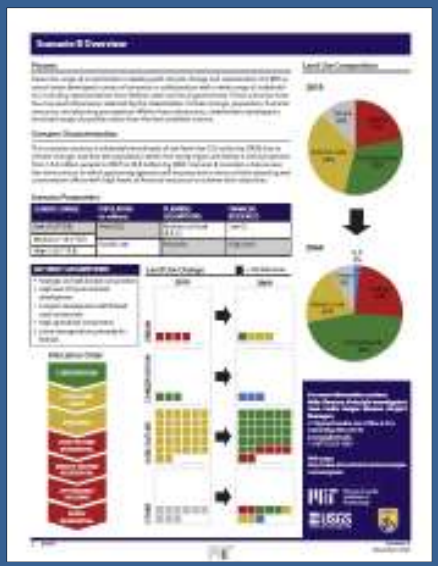


FY 2010

- Carbon sequestration
- Climate envelop models developed for 26 terrestrial species

Should we be thinking about this issue differently?

Before moving onto action and strategy options, it can be valuable to reflect on whether the, discussion of impacts alters how the group wants to frame the focal issue or problem. This might include asking:

- Do the management implications of the scenarios fall within the purview of the current participants, or should others be involved?
- Is there key information missing?
- Do we need to reassess our goal or management objectives for this resource?

FY 2011-2012

- PFLCC and developing agreed to fund scenarios
  - Project boundary moved to PFLCC line
  - CLIP database enhanced with climate change
- Statewide Beaches HCP
  - 17 T&E species
- Helped justify Everglades Headwaters NWR PPP and other documents threats sections
- Original scenarios used for bonneted bat listing package.
- SECSC funded connectivity project for climate envelop team
- Vulnerability assessments

Peninsular Florida Landscape Conservation Cooperative

- Collaborative applied conservation science partnership
- Build on existing initiatives
- Science and tools to address climate change and other limiting factors
  - Development
  - Invasive species
  - Water management
- FWS, USGS & NPS will provide initial funding and staff; base funding in future years

Cooperative Conservation Blueprint

A Bold vision of Florida's future

- If we can envision our future we can create that future

FY 2013-2014

- Scenarios reviewed, new high SLR 2.0 meter, low SLR 0.3 m
  - Cover the whole state
  - Reevaluate the types of agriculture (timber)
- Harmonized SLR scenarios to 0.5, 1.0, 1.5, 2.0m
- PFLCC integrated science team funded for Everglades headwater NWF SDM and optimization model development for parcel selection
- Focus on PES in middle part of the state
- Post doc for conservation targets for the PFLCC
- Support Additional candidate species listing packages.
- Helped justify refuge comp plans
- KeysMAP

Everglades Headwaters NWR

Partnerships : Working with The Nature Conservancy, NRCS WRP, and other groups

Everglades Headwaters NWR:50,000 acres fee, 100,000 acres easements

Dynamic Reserve Design in the Face of Climate Change and Urbanization

The objective : To develop the problem in a decision-analytic framework, in which the purpose is not prioritization of parcels, but identification of parcels needed to achieve conservation targets at minimal cost and within other constraints.

Importance: How important are the predicted climate change impacts addressed by this adaptation option? Are they likely to affect unique or valuable species, ecological functions, or other natural resources? What is at stake if we do nothing?

Urgency: What are the costs of delaying action? Is it likely to cost more to implement later rather than now? Will we lose species, resources, or options by delaying action? Are the consequences of not acting now irreversible?

Co-Benefits: Are there benefits to this action beyond the adaptation objective? Will the total benefits exceed the cost of implementation? Are costs and benefits equitably distributed?

Feasibility: How feasible is the proposed action given existing laws, regulations, policies and the political climate? How technically feasible is it? Is there an opportunity to adapt existing strategy/actions, or will entirely new initiatives be needed?

Robustness : What is the likelihood that the proposed action will be effective across the range of future scenarios? Does it allow for adaptive management?

Cost: How costly will this proposed action be in terms of time, money or other resources? Is there opportunity to adapt existing strategy/actions?

Others: Consistency with national laws/policies, Equity, Impact on greenhouse gas emissions, Economic efficiency, Technical feasibility, Scale specificity

Possible Future PFLCC Scenario Uses

- Exploring payment for ecosystem services incentives
- Implementation of corridors
- Conservation through easements/fee simple purchase
- Adaptation plans
- Surrogate species planning

Scenario B

Scenario C

Scenario C

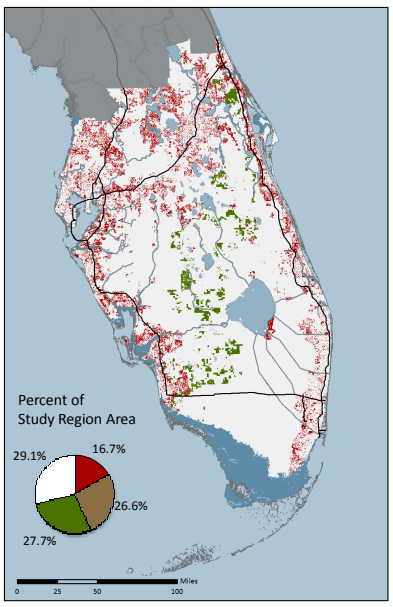
Scenario B

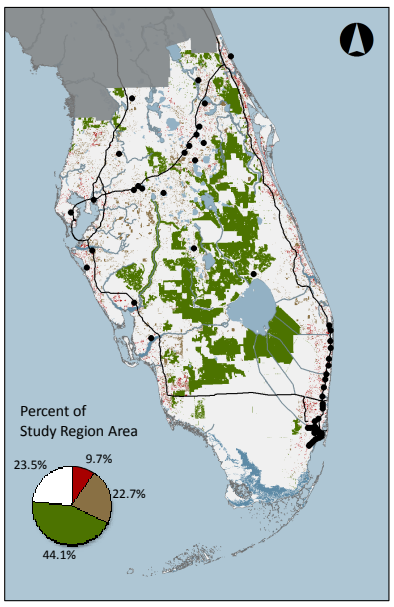
Year: 2060

Only new area allocated

Allocated Land Uses
- Residential
- Conservation
- Agriculture
- Transit Oriented Dev.
- Sea Level Rise

Current Land Uses
- Residential
- Conservation
- Agriculture
- Interstate Highways
- Major Lakes
- Major Rivers





High Sea Level Rise – Low Financial Resources
Business as Usual – Double Population

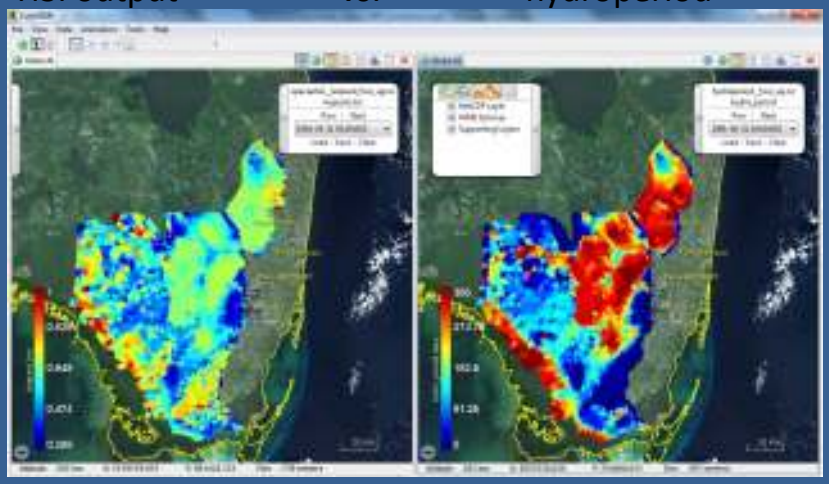
Low Sea Level Rise – High Financial Resources
Proactive – Trend Population

Problems, potential pitfalls, opportunities

- End user analysis
- Data storage and information keeper
- Information dissemination
  - Portals
  - Websites
  - Short documents
  - Publications
- Data visualization
- Champions
- Funding stream

Visualizing model data using EverVIEW

HSI output vs. hydroperiod

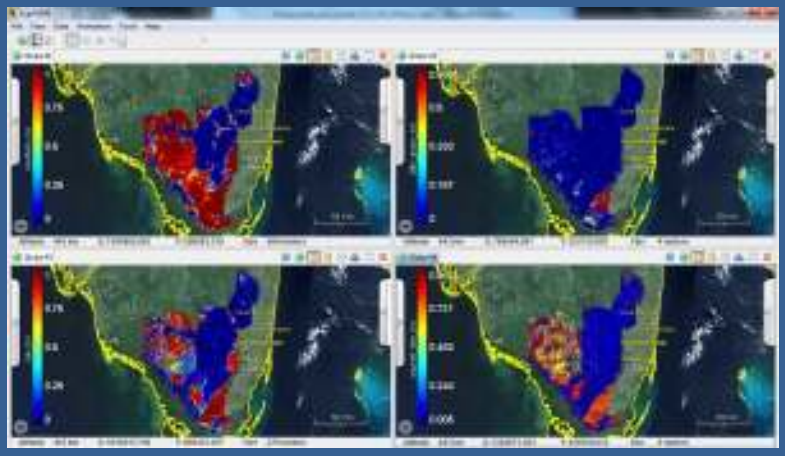


NOTE: FABRICATED DATA FOR ILLUSTRATIVE PURPOSES!

Compare four alternatives side by side

Alt W

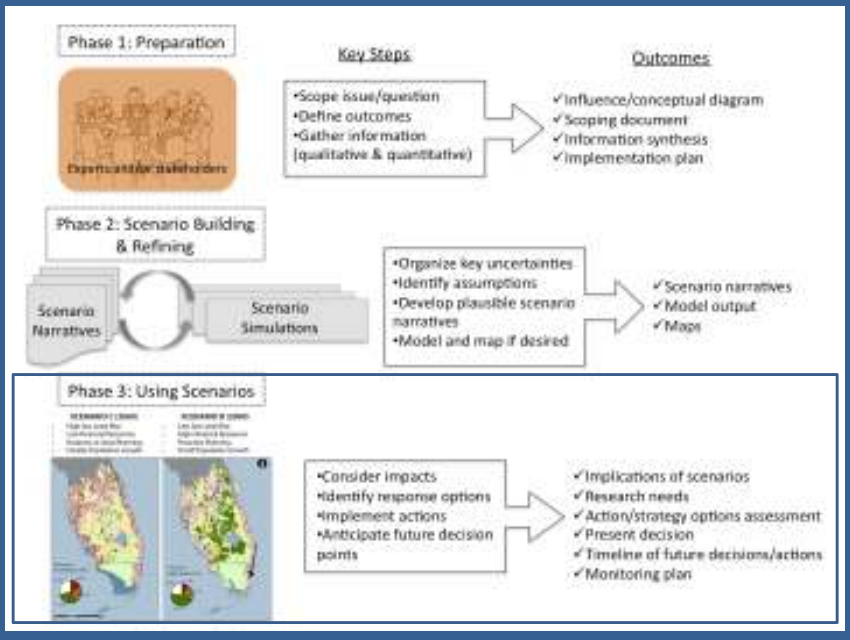
Alt Y



Alt X

Alt Z

REMINDER: THESE ARE MADE UP DATA!

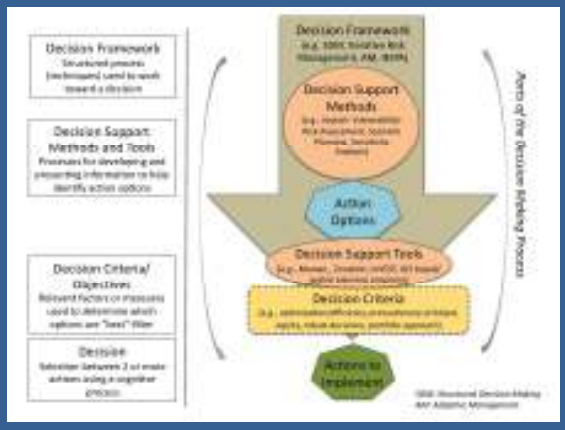


Questions?

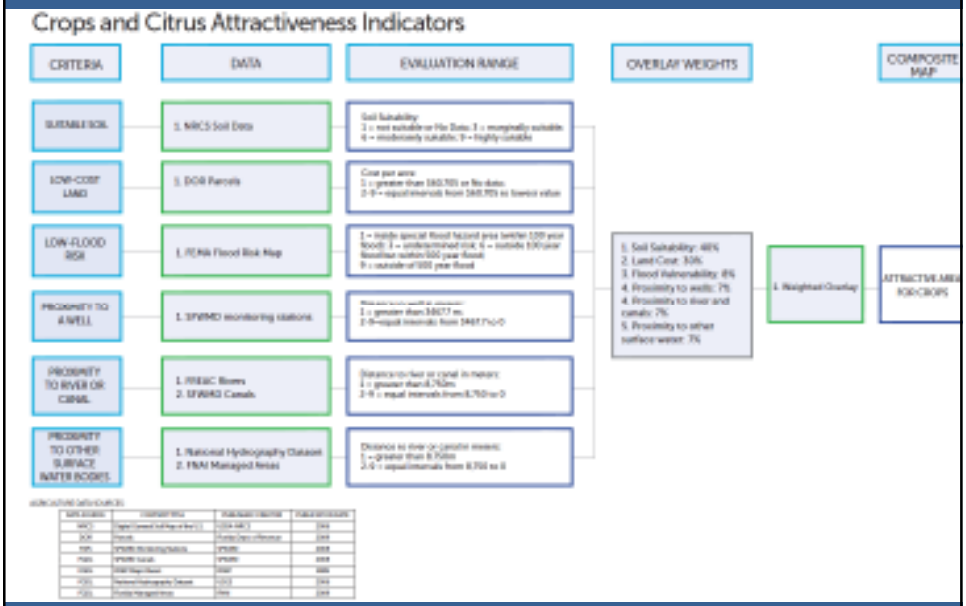
Cabinet meeting of the island nation, Maldives

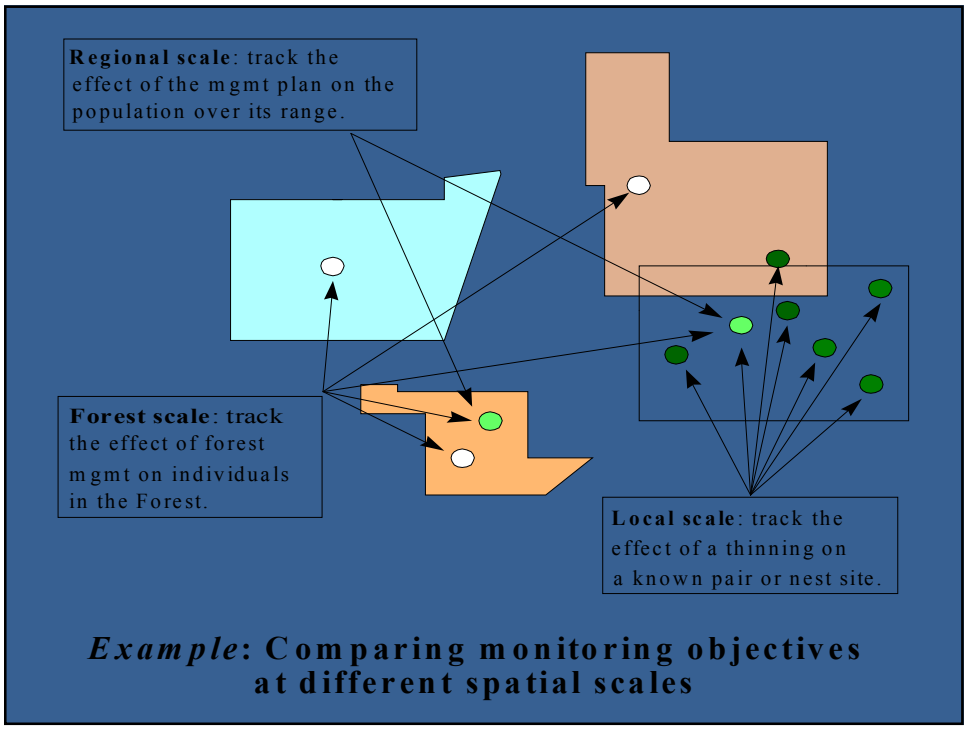
Steve_Traxler@fws.gov

Figure: Module 9 links original objectives back to the scenarios and the potential decisions or outcomes selected by the scenarios.

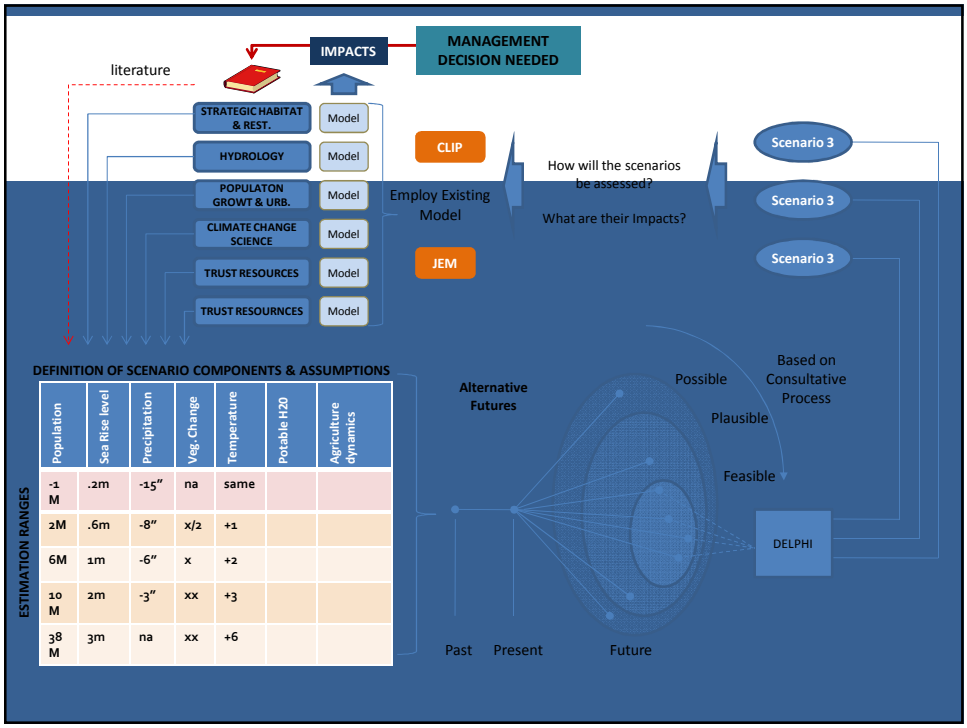


Crops and Citrus Attractiveness

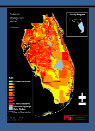
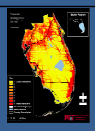
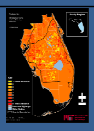
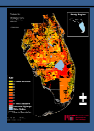
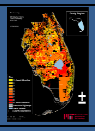
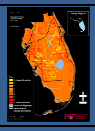
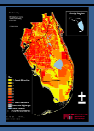
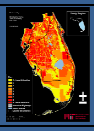
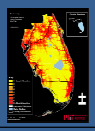
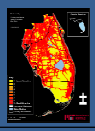
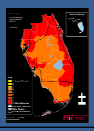
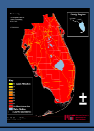


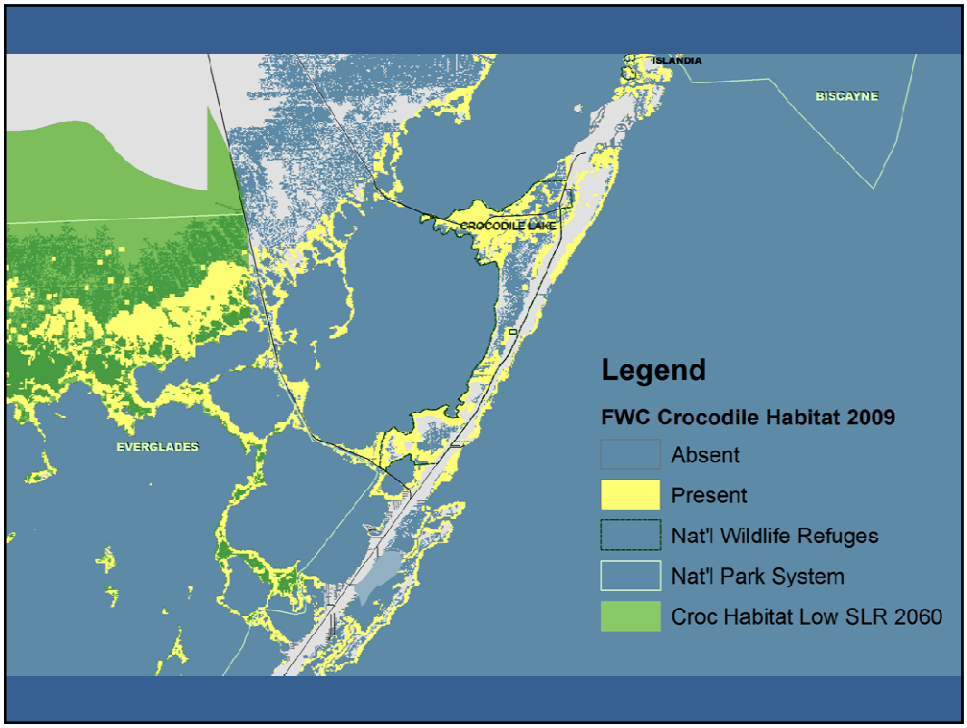


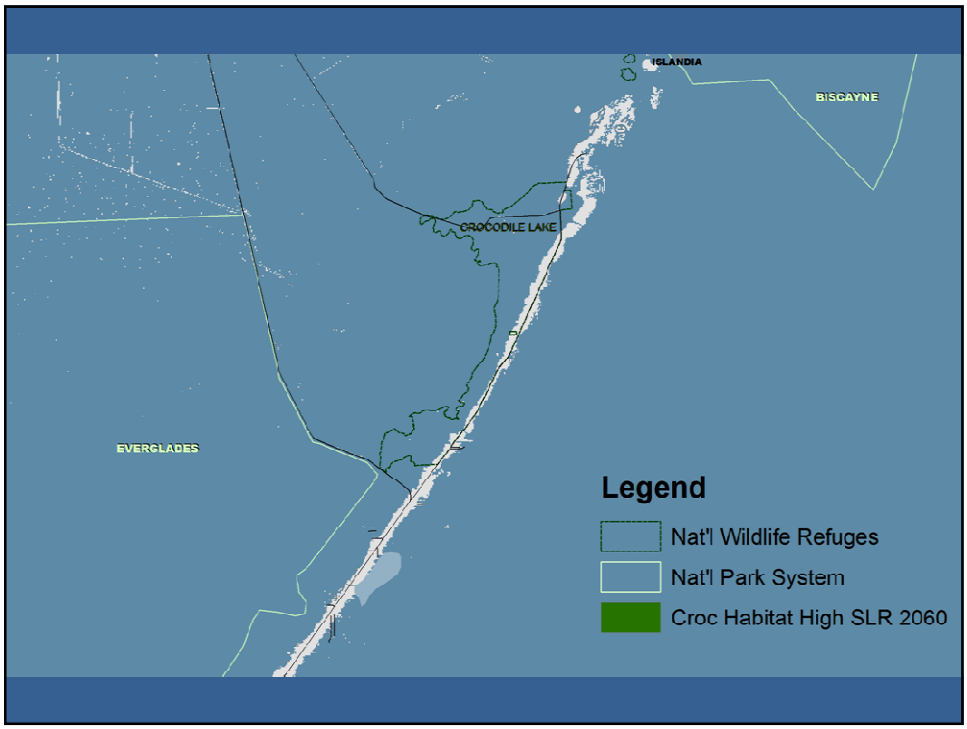
***Example*: Comparing monitoring objectives at different spatial scales**



Different Masks for Different Sectors, Budgets, and Political Environments

	BAU$	BAU$$$	PRO$	PRO$$$
Urban Mask				
Conservation Mask				
Universal Mask-NO ONE GETS THIS LAND				


ISLANDIA
BISCAYNE
CROCODILE LAKE
EVERGLADES
Legend
FWC Crocodile Habitat 2009
Absent
Present
Nat'l Wildlife Refuges
Nat'l Park System
Croc Habitat Low SLR 2060


ISLANDIA
BISCAYNE
CROCODILE LAKE
EVERGLADES
Legend
Nat'l Wildlife Refuges
Nat'l Park System
Croc Habitat High SLR 2060

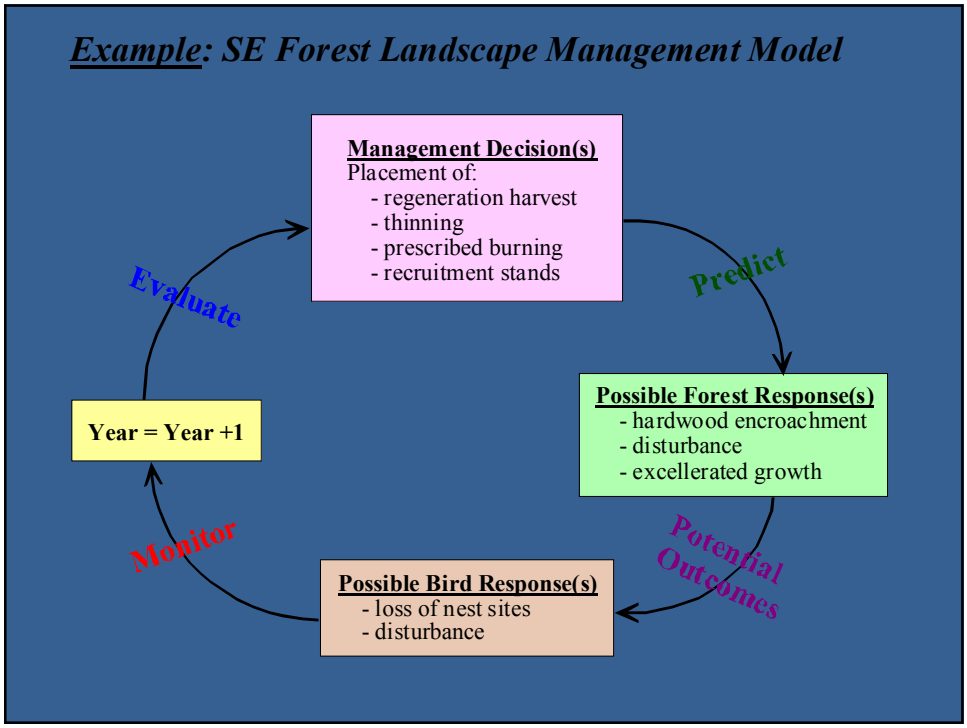
Example: Testing Sedimentation from Road Development/Maintenance

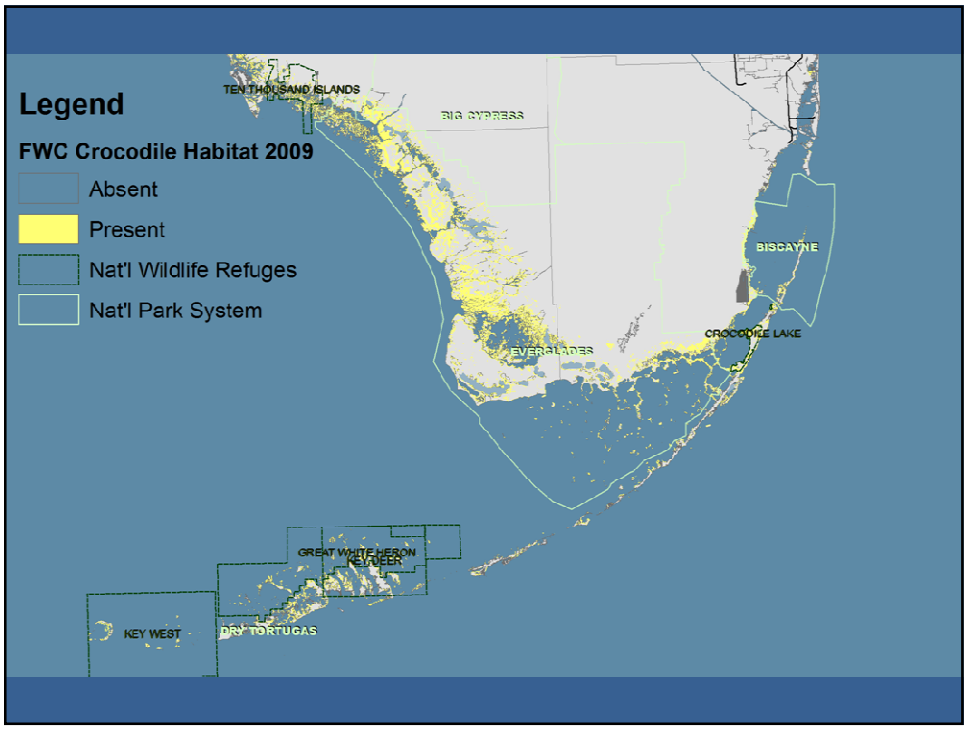
Mgmt. Objective	Test (and monitoring) Hypothesis	Outcome	Data	Management Trigger	Response
Minimize sediment delivery to streams (from roads)	H_0: Sediment delivery does not differ from (model) predictions (H_1: it does differ)	Estimate expected amount of sediment delivery (from action)	Measure in tons (of sediment) per year (applying sampling design)	Net increase does not exceed 49% (if exceeds 49%)	Revise practices / Modify rules

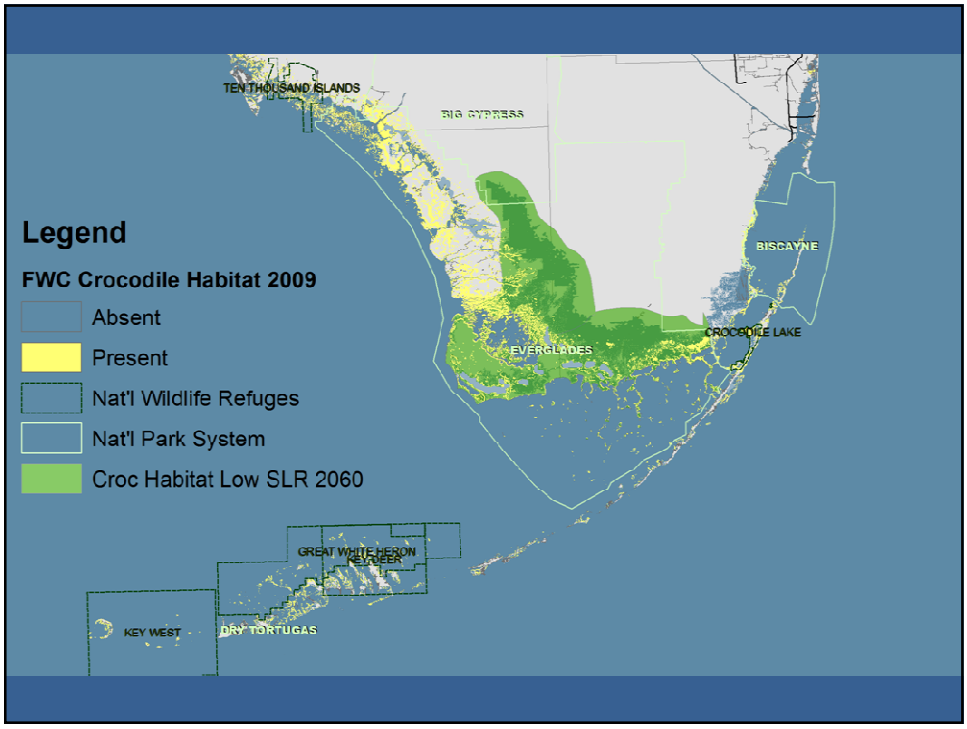
(Plum Creek HCP: www.fws.gov/r1srbo/SRBO)

Summary

- *Florida is experiencing various levels of climate change, especially SLR*
- *A number of partnering organizations including the USFWS are developing an LCC for Florida*
  - *Partnering for conservation*
- *Alternative futures/scenarios are a viable tool for adaptation planning for climate change*
- *The new refuge proposals are a great tool in adaptation planning*


Example: SE Forest Landscape Management Model
Management Decision(s)
Placement of:
- regeneration harvest
- thinning
- prescribed burning
- recruitment stands
Predict
Possible Forest Response(s)
- hardwood encroachment
- disturbance
- excellerated growth
Potential Outcomes
Possible Bird Response(s)
- loss of nest sites
- disturbance
Monitor
Year = Year +1
Evaluate


Legend
FWC Crocodile Habitat 2009
Absent
Present
Nat'l Wildlife Refuges
Nat'l Park System
TEN THOUSAND ISLANDS
BIG CYPRESS
BISCAYNE
EVERGLADES
CROCODILE LAKE
GREAT WHITE HERON
KEY WEST
DRY TORTUGAS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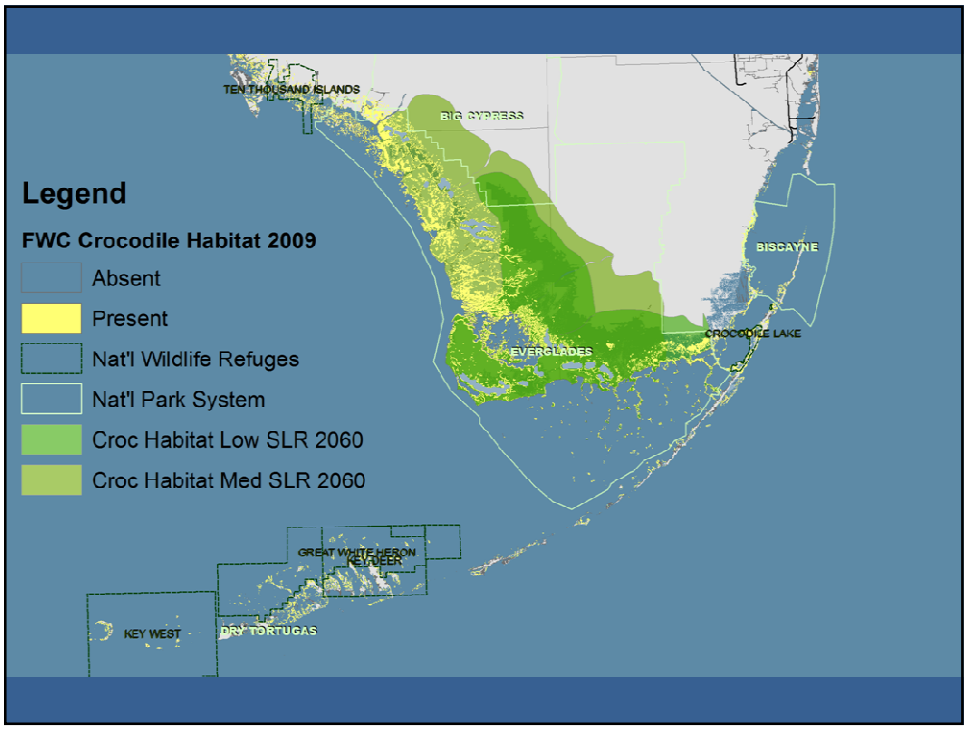
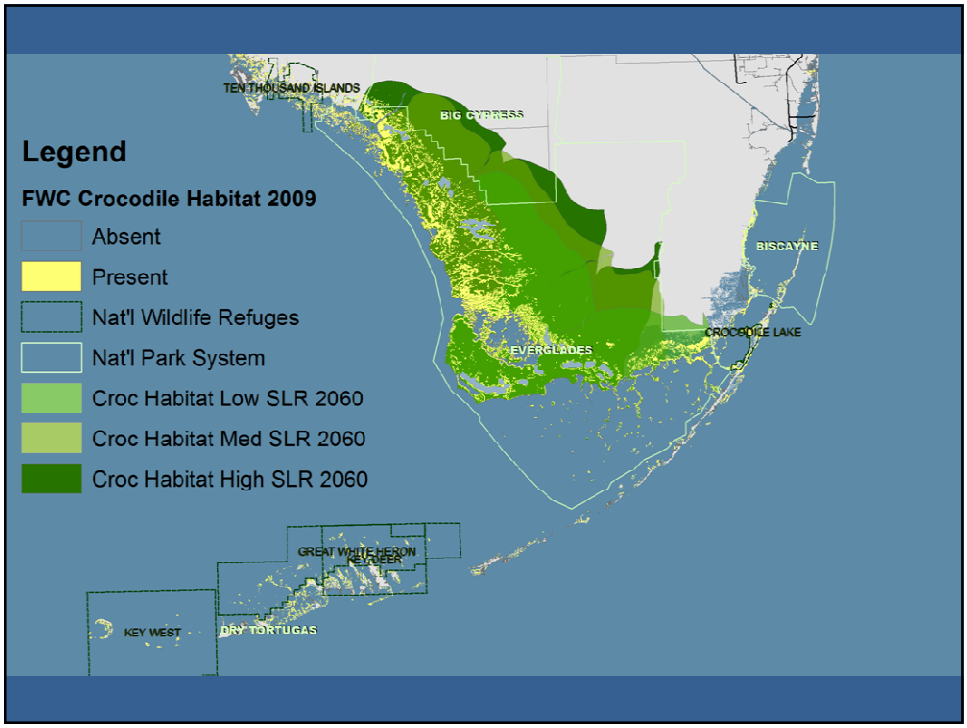
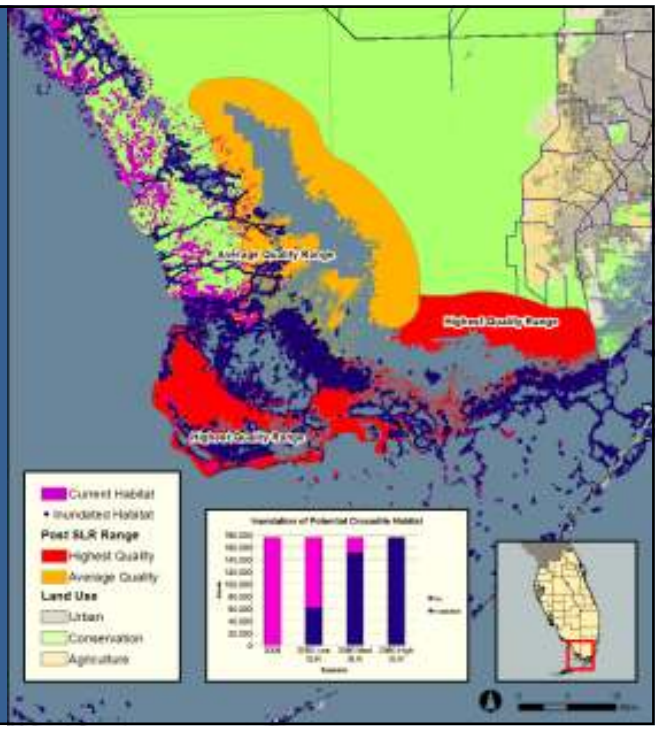
TEN THOUSAND ISLANDS
BIG CYPRESS
BISCAYNE
EVERGLADES
CROCODILE LAKE
GREAT WHITE HERON
KEY DEER
KEY WEST
DRY TORTUGAS


Legend
FWC Crocodile Habitat 2009
Absent
Present
Nat'l Wildlife Refuges
Nat'l Park System
Croc Habitat Low SLR 2060
Croc Habitat Med SLR 2060
TEN THOUSAND ISLANDS
BIG CYPRESS
BISCAYNE
EVERGLADES
CROCODILE LAKE
GREAT WHITE HERON
KEY DEER
KEY WEST
DRY TORTUGAS

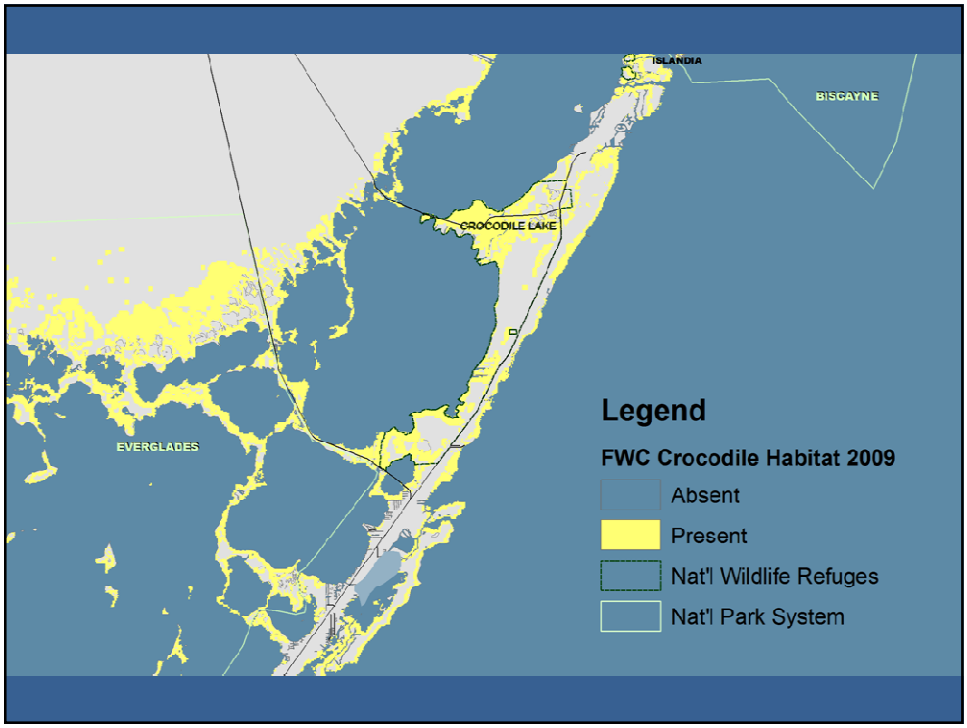


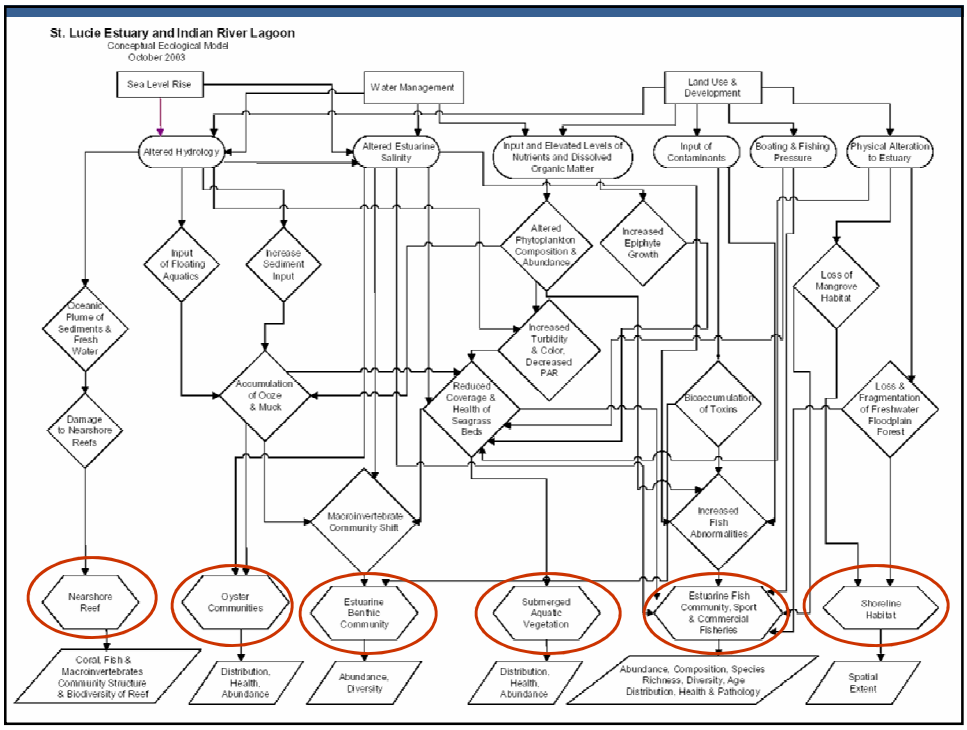
Pilot Project: Climate Vulnerability Assessment

AMERICAN CROCODILLE
Conflict
with low sea level rise



Department of Urban Studies and Planning


ISLANDIA
BISCAYNE
CROCODILE LAKE
EVERGLADES
Legend
FWC Crocodile Habitat 2009
Absent
Present
Nat'l Wildlife Refuges
Nat'l Park System

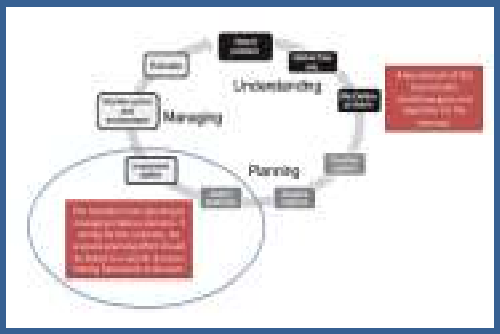

St. Lucie Estuary and Indian River Lagoon
Conceptual Ecological Model
October 2003
Sea Level Rise
Water Management
Land Use & Development
Altered Hydrology
Altered Estuarine Salinity
Input and Elevated Levels of Nutrients and Dissolved Organic Matter
Input of Contaminants
Boating & Fishing Pressure
Physical Alteration to Estuary
Input of Floating Aquatics
Increase Sediment Input
Altered Phytoplankton Composition & Abundance
Increased Epiphyte Growth
Loss of Mangrove Habitat
Oceanic Plume of Sediments & Fresh Water
Increased Turbidity & Color, Decreased PAR
Accumulation of Ooze & Muck
Reduced Coverage & Health of Seagrass Beds
Bioaccumulation of Toxins
Loss & Fragmentation of Freshwater Floodplain Forest
Damage to Nearshore Reefs
Macroinvertebrate Community Shift
Increased Fish Abnormalities
Nearshore Reef
Oyster Communities
Estuarine Benthic Community
Submerged Aquatic Vegetation
Estuarine Fish Community, Sport & Commercial Fisheries
Shoreline Habitat
Coral, Fish & Macroinvertebrates Community Structure & Biodiversity of Reef
Distribution, Health, Abundance
Abundance, Diversity
Distribution, Health, Abundance
Abundance, Composition, Species Richness, Diversity, Age Distribution, Health & Pathology
Spatial Extent

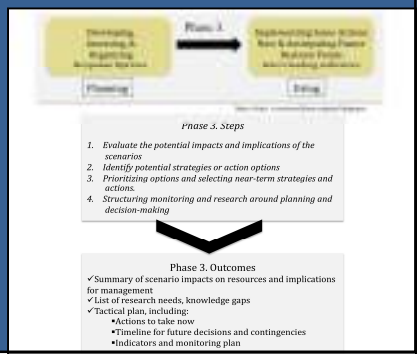
Common Objectives or Requirements	"Off-the-shelf" Scenarios	"Tailored" Scenarios
To explore highly uncertain, catastrophic or non-linear events	Of limited use	Most useful
To produce quantitative and 'definitive' outputs*	Most useful	Useful
To use a process that relies on publically accessible data	Most useful	Useful
That the process be expert driven	Most useful	Useful
To produce scenarios that will serve as a communication tool	Of limited use	Most useful
To understand the potential impacts of climate change	Most useful	Most useful
To incorporate diverse knowledge and opinions	Of limited use	Most useful
To emphasize learning in the scenario process	Of limited use	Most useful
To develop a clear strategic direction or decision recommendations	Useful	Useful
To get "buy-in" from conventional decision makers	Most useful	Of limited use

Quantitative-Qualitative Products Questions

1. What kinds of outcomes are needed? How important are quantitative results in meeting mandates and "selling" outcomes?
2. How will you use the results? And, related, what other decision-support methods and/or tools are being applied to the issue? Is a scenario planning effort contributing to an existing or more comprehensive planning process?
   - Issue scoping, common understanding
   - Vulnerability/impact assessment
   - Consider policy/mgt alternatives
   - Develop action & decision time line
   - Feeding into other decision processes
3. What is your decision or planning timeframe?
   - Simulating qualitative narratives into quantitative, spatially explicit outputs may be time-consuming, challenging and expensive (Mahmoud et al. 2009, Walz et al. 2007).
4. What kinds of uncertain drivers are relevant to focal issue/question being addressed?
   - If you are incorporating human dimensions, quantitative options may be limited.
   - Are necessary data available?

Figure 3.13. A slight modification of Figure 2.1 highlighting how outcomes involving the transition from assessing options to selecting and implementing options require decisions, which may best be made with a structured framework.





Phase 3. Steps

1. *Evaluate the potential impacts and implications of the scenarios*
2. *Identify potential strategies or action options*
3. *Prioritizing options and selecting near-term strategies and actions.*
4. *Structuring monitoring and research around planning and decision-making*

Phase 3. Outcomes

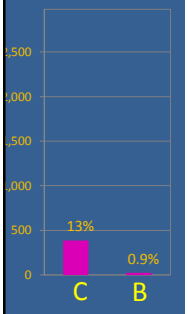
✓Summary of scenario impacts on resources and implications for management
✓List of research needs, knowledge gaps
✓Tactical plan, including:
- •Actions to take now
- •Timeline for future decisions and contingencies
- •Indicators and monitoring plan

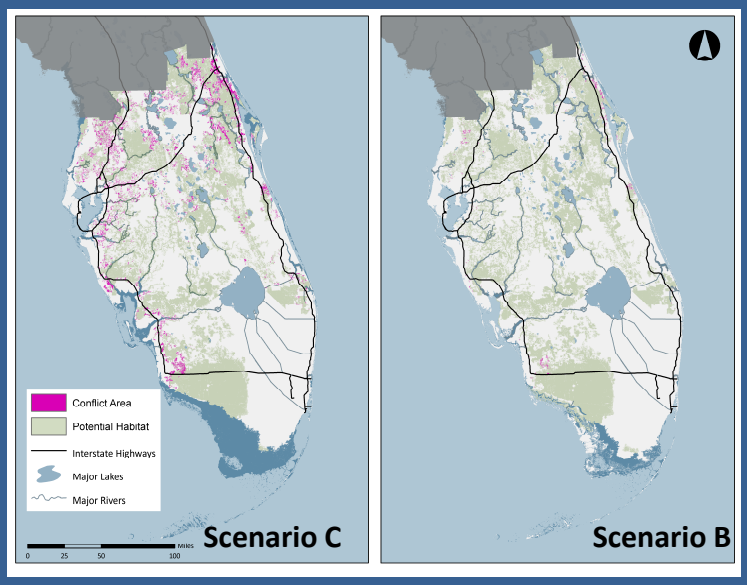
Development Conflict With Suitable Black Bear Habitat

Total Habitat Acreage in Thousands:

3,000

Conflict Area:





High Sea Level Rise – Low Financial Resources
Business as Usual – Double Population

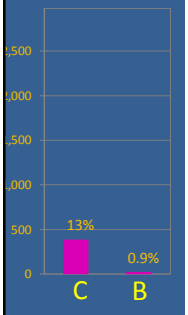
Low Sea Level Rise – High Financial Resources
Proactive – Trend Population

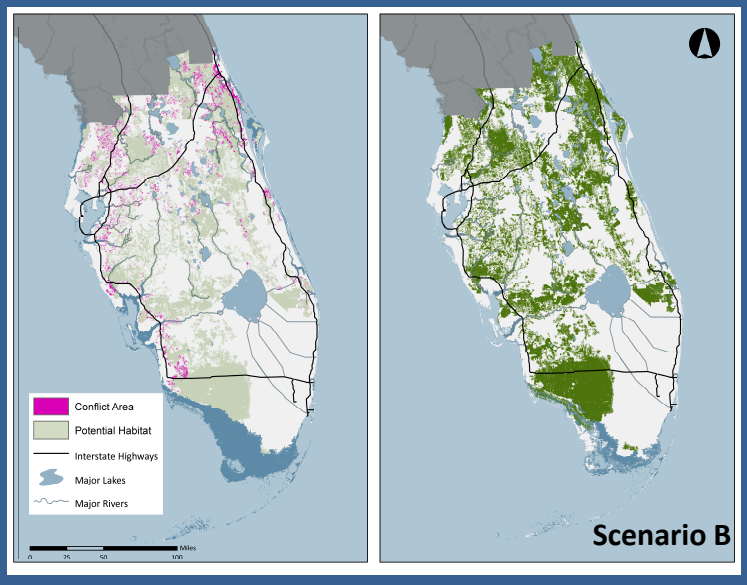
Development Conflict With Suitable Black Bear Habitat

Total Habitat Acreage in Thousands:

3,000

Conflict Area:





High Sea Level Rise – Low Financial Resources
Business as Usual – Double Population

Low Sea Level Rise – High Financial Resources
Proactive – Trend Population

Proactive Conservation Network

1. **Structural Corridors:**

2km wide area that connects existing patches of conservation (based on CLIP, SHCA priority data, FEGN critical linkages as weighted by stakeholders)

2. **Interior Habitat Corridors:**

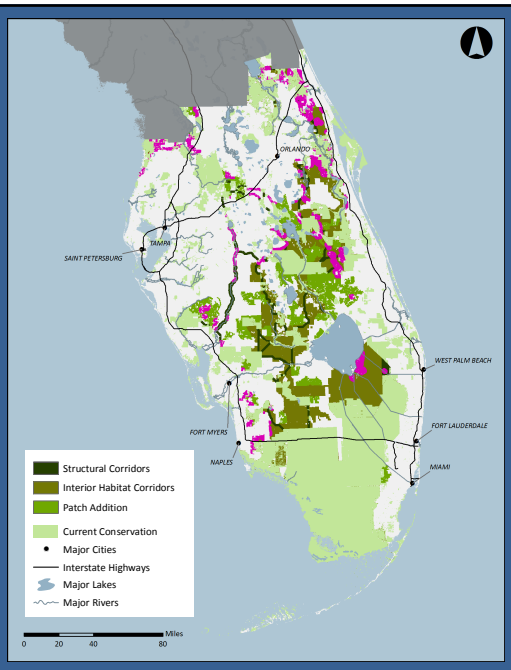
Expansion of structural corridors to provide core habitat (includes all of top stakeholder-weighted priority area)

3. **Patches:**

Adds largest remaining patches based on CLIP priority 1 data to expand existing conservation areas

4. **Potential Urban Conflict Area:**

Areas within the potential conservation network that are vulnerable to development



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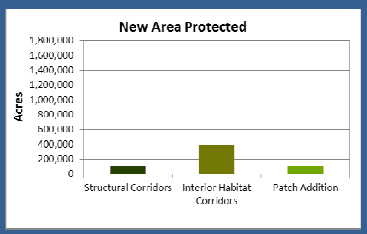
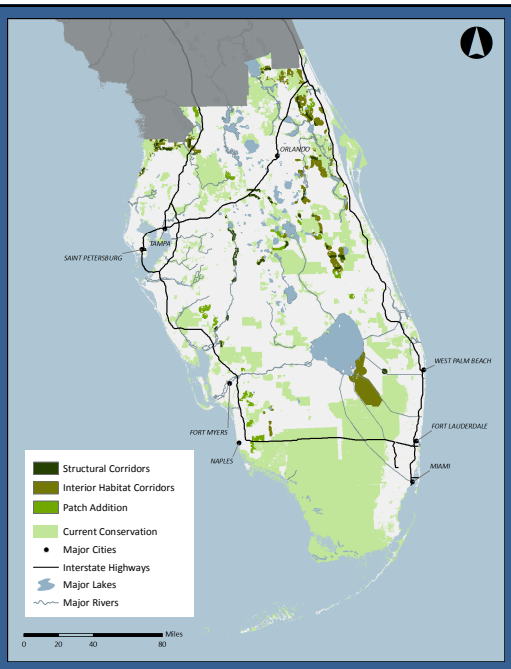
Proactive Conservation Strategy:

Time Period: 2010-2020

1. Protect all priority area in conflict with potential urban development

2. Interior Habitat Corridor area around EAA





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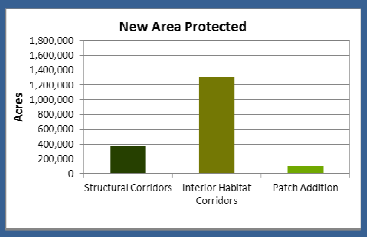
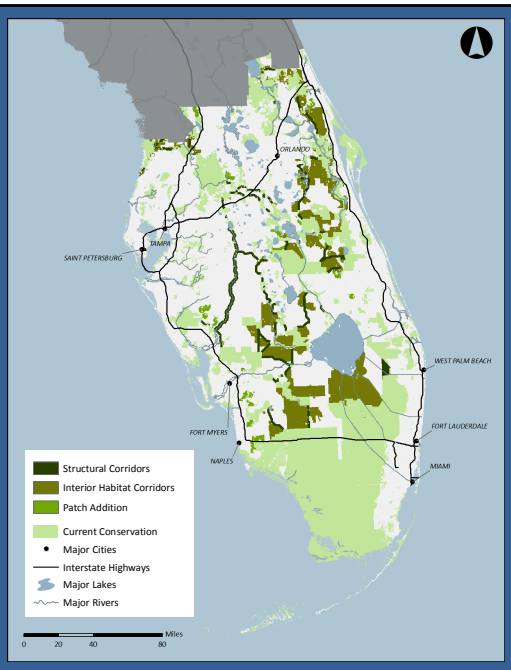
Proactive Conservation Strategy:

Time Period: 2020-2040

1. Protect remaining Structural Corridor area

2. Interior Habitat Corridor area





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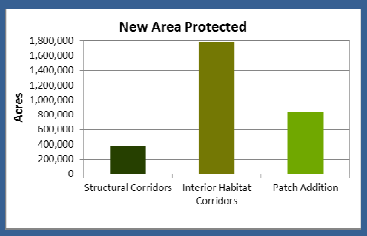
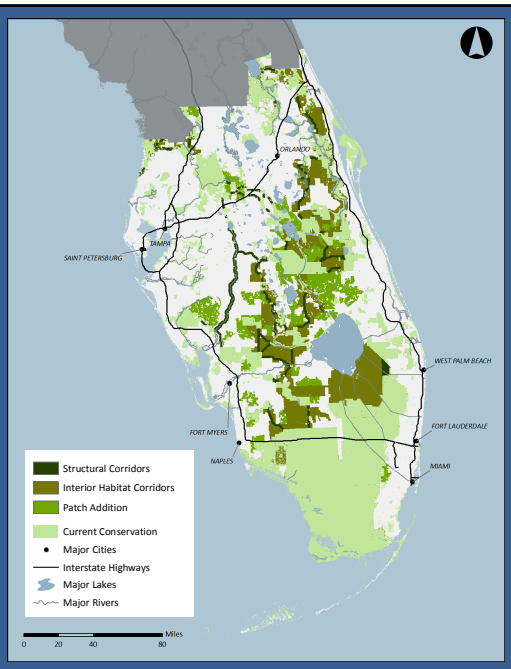
Proactive Conservation Strategy:

Time Period: 2040-2060

1. Protect remaining Interior Habitat Corridor area

2. Remaining large Patch area





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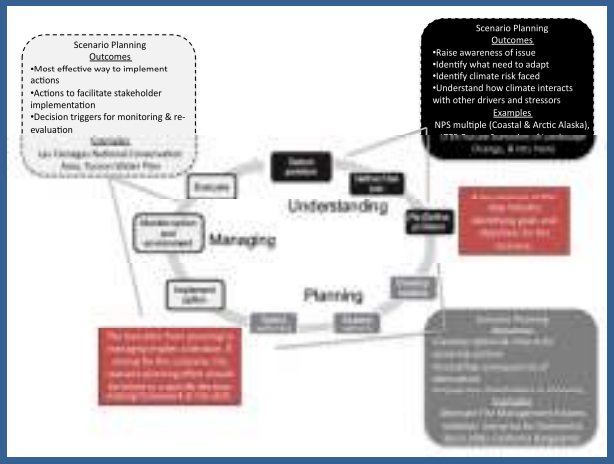
As the future unfolds, scenarios should be reviewed and evaluated to determine whether the current plans should be modified or if new scenarios are needed. While the value of good scenarios includes their ability to help decision-makers avoid dangers and achieve desired objectives (Godet and Roubelat 1996), these attributes can only be tested at the conclusion of scenario development through scenario monitoring and post-audits, a process that is also widely referred to as adaptive management.— Mahmoud et al. 2009

Figure: Module 10 links original objectives back to the scenarios and the potential decisions or outcomes selected by the scenarios.



Actions: take-home messages

- **Objectives answer "Why?" Management actions answer "How?"**
- **A useful set of possible actions requires interaction among stakeholders, managers, and scientists**
- **Useful actions are limited in number, and span the range of desirable outcomes and maximize differences in system responses**
- **As with objectives, the set of actions may not be immediately obvious**
- **Visualization tools/techniques are very important to convey the scenario results**